

CLAIMS

1. A method of reducing a metal-oxygen compound wherein carbon acts as a reducing agent, comprising:
 - 5 in a first reaction stage, passing CO gas into a reaction chamber containing said metal-oxygen compound, under conditions such that CO is converted to solid carbon and carbon dioxide thereby introducing the solid carbon so formed to said metal-oxygen compound, and
 - 10 in a second reaction stage, causing said carbon, which is introduced to the metal-oxygen compound in said first reaction stage, to reduce said metal-oxygen compound, wherein there is present, at least in said second reaction stage, a first promoter material effective to promote the reduction of said metal-oxygen compound, the first promoter material comprising a first promoter metal and/or a compound of a first promoter metal.
- 15 2. A method according to claim 1, wherein the method is performed continuously, said first and second reaction stages being performed simultaneously and said metal-oxygen compound being moved from a first reaction region where said first reaction stage takes place to a second reaction region where said second
- 20 reaction stage takes place.
3. A method according to claim 2, wherein CO gas formed in the second reaction stage is used in said first reaction stage.
- 25 4. A method according to any one of the preceding claims, wherein said second reaction stage is performed at a higher temperature than said first reaction stage.
- 30 5. A method according to any one of the preceding claims, wherein said first promoter material is said first promoter metal, or a first promoter metal carbide, a first promoter metal hydride or a first promoter metal nitride, or a combination thereof.
- 35 6. A method according to any one of the preceding claims, wherein said first promoter material is in powder form.

7. A method according to any one of the preceding claims, wherein said first promoter metal is the same as the metal of said metal-oxygen compound.
- 5 8. A method according to any one of the preceding claims, wherein, at least in said first reaction stage, a second promoter material is present, the second promoter material comprising a second promoter metal and/or a compound of a second promoter metal which promotes the conversion of CO to carbon and carbon dioxide.
- 10 9. A method according to claim 8, wherein said second promoter material is said second promoter metal, or a second promoter metal carbide, a second promoter metal hydride or a second promoter metal nitride, or a combination thereof.
- 15 10. A method according to claim 9, wherein said second promoter material is in powder form.
11. A method according to any one of claims 1 to 10, wherein said metal-oxygen compound is in the form of a conglomerate formed from powder.
- 20 12. A method according to any one of claims 1 to 11, wherein said metal-oxygen compound and said first promoter material, and said second promoter material if present, are in the form of conglomerate formed from their powders.
- 25 13. A method according to any one of the preceding claims, wherein the metal of said metal-oxygen compound is Fe, Cu, Co, Ni, Ru, Rh, Pd, Pt or Ir.
14. A method according to any one of the preceding claims, wherein said first reaction stage is performed below 650°C.
- 30 15. A method according to any one of the preceding claims, wherein the metal-oxygen compound comprises iron-oxygen compound, such as iron oxide and/or iron hydroxide and/or iron carbonate.

16. A method according to any one of the preceding claims, wherein said first promoter metal, and second promoter metal if present, is iron.
- 5 17. A method according to claim 15 or 16, wherein said second reaction stage is performed between 550 and 900°C.
- 10 18. A method according to any one of the preceding claims, wherein said metal-oxygen compound comprises a mixture of at least two metal-oxygen compounds, wherein the metals in the metal-oxygen compounds are different and wherein each of the metals comprises Fe, Cu, Co, Ni, Ru, Rh, Pd, Pt or Ir.
- 15 19. A method according to any one of the preceding claims, carried out in a shaft furnace, a blast furnace, a fluidised bed, a rotary hearth furnace, a rotary kiln furnace, a cyclone furnace or a batch-type furnace.
- 20 20. A method according to any one of the preceding claims, wherein a substantially solid reaction product is produced in the second reaction stage and wherein a portion of said reaction product from said second reaction stage is introduced into said first reaction stage.
21. A method according to any one of the preceding claims, wherein gaseous reaction product is extracted and reintroduced into the process.
- 25 22. Apparatus for carrying out the reduction of a metal-oxygen compound wherein carbon acts as a reducing agent, comprising:
a first stage reaction chamber adapted to hold a solid charge of the metal-oxygen compound,
an inlet to said first reaction chamber for entry of said metal-oxygen compound,
a second stage reaction chamber,
30 transport means for transferring the solid charge, following reaction in said first stage reaction chamber, from said first stage reaction chamber into said second stage reaction chamber,
means for passage of CO gas from said second stage reaction chamber to said first stage reaction chamber, and

a discharge outlet for discharge of substantially solid reaction products from said second stage reaction chamber.

23. Apparatus according to claim 22, having
5 an outlet for gaseous reaction product from said first stage reaction chamber and means for reintroducing gaseous reaction product to said second stage reaction chamber.
24. Apparatus according to claim 22 or 23, having
10 means for reintroducing substantially solid reaction product discharged via said discharge outlet to said first stage reaction chamber.
25. Apparatus according to claim 22, 23 or 24, including means for generating hot
15 CO gas to be fed into said second stage reaction chamber.
26. Apparatus according to any one of claims 22 to 25, including a fluidised bed reactor providing the first stage reaction chamber and/or the second stage reaction chamber.